COMPUTER-AIDED ACQUISITION AND LOGISTIC SUPPORT GATEWAY DEVELOPMENT

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DoD is committed to applying the best in modern technology to improve transfer of weapon systems technical information among DoD organizations and weapon systems contractors. To foster the application of such technology, DoD established the CALS steering group. The CALS communications working group provides advice and assistance to the steering group on data transmission requirements and communications protocols. This report explores how near- and mid-term gateway technologies make possible direct data communications among diverse hardware configurations. These gateways will facilitate the location, collection, and analysis of data across heterogeneous computer systems and data networks.

LMI recommends that CALS participants implement gateway capabilities in the following order: Open Systems Interconnection (OSI)/DoD gateway, Standard Generalized Markup Language (SGML), Computer Graphics Metafile (CGM) and raster graphics, access to high-speed data networks, Initial Graphics Exchange Specification (IGES), and Product Data Exchange Specification (PDES). The order is based on the multiple protocol suites on data networks, the need to start with relatively simple textual data and progress to more complex graphics and manufacturing data, and the requirement for higher data speeds before larger files can be sent quickly. Implementation of these gateway capabilities is a critical step in achieving the interoperability and standardization goals of the CALS program.

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Executive Summary

COMPUTER-AIDED ACQUISITION AND LOGISTIC SUPPORT GATEWAY DEVELOPMENT

The Department of Defense is committed to applying the best in modern technology to improve transfer of weapon systems technical information among DoD organizations and weapon systems contractors. To foster the application of such technology, DoD established the Computer-aided Acquisition and Logistic Support (CALS) steering group. The CALS communications working group provides advice and assistance to the steering group on data transmission requirements and communications protocols. An earlier Logistics Management Institute (LMI) study for the CALS working group made specific recommendations and presented a plan to use and implement the Open Systems Interconnection (OSI) standards for CALS telecommunications. The CALS Telecommunications Plan* addresses near-, mid-, and long-term gateway activities. This report explores in more detail how near- and mid-term gateway technologies make possible direct data communications among diverse hardware configurations. These gateways will facilitate the location, collection, and analysis of data across heterogeneous computer systems and data networks.

The analysis resulted in the following conclusions:

- All CALS data communications solutions must use the Government Open Systems Interconnection Profile. At the same time, communications among systems operating with the existing DoD protocol suite must be maintained for the next 7 to 10 years.
- Gateway functionality for all but the simplest text transmissions should be placed on the users' local area network or within their host machines. Placing the gateway on a wide-area network would result in poorer system response to the user.
- The simplest CALS specification to implement ıe Standard Generalized Markup Language (SGML) for sending text. Computer Graphics Metafile (CGM) and raster graphics follow in order of increasing difficulty and are necessary for the graphics that accompany the text. The Initial Graphics

*LMI Report PL810R1 *Computer-aided Acquisition and Logistic Support Telecommunications Plan*. Doby, John S. Aug 1989.

Exchange Specification (IGES) is third, since ambiguities remain. The Product Data Exchange Specification (PDES) is still in progress and will be implemented after the others.

- CALS implementation would be accelerated by quick resolution of the ambiguities in CALS data format standards, as uncovered by the CALS Test Network. Refining these standards will reduce the need for gateways tailored to particular implementations of each CALS standard.

- Intelligent gateway efforts to date have typically involved lower volumes of data than envisioned under CALS. As CALS matures, more information will be available for electronic transfer, including the larger data files associated with engineering drawings.

- To help define CALS gateway requirements, each Military Service and agency must provide a traffic profile of their anticipated CALS data flow. Government network planners need to factor these requirements into their data communications planning along with the Electronic Data Interchange (EDI) and the Modernization of Defense Logistics Standard Systems (MODELS) efforts. These CALS profiles will provide the rationale for higher data transmission rates.

LMI recommends that CALS participants implement gateway capabilities in the following order: OSI/DoD gateway, SGML, CGM and raster graphics, access to high-speed data networks, IGES, and PDES. The order is based on the multiple protocol suites on data networks, the need to start with relatively simple textual data and progress to more complex graphics and manufacturing data, and the requirement for higher data speeds before larger files can be sent quickly. Implementation of these gateway capabilities is a critical step in achieving the interoperability and standardization goals of the CALS program.

CONTENTS

TABLES

FIGURES

SECTION 1

INTRODUCTION

1.1 BACKGROUND

The Department of Defense is committed to applying the best in modern technology to improve transfer of weapon systems technical information among DoD organizations and weapon systems contractors. To foster the application of such technology, DoD established the Computer-aided Acquisition and Logistic Support (CALS) steering group. The CALS communications working group provides advice and assistance to the steering group on data transmission requirements and communications protocols. The working group focuses on communications requirements for transferring CALS data within DoD and between DoD and contractors.

Earlier work by LMI for the working group made specific recommendations and provided a telecommunications plan to implement the Open Systems Interconnection (OSI) standards for CALS telecommunications. Section 3 and Appendices C, D, and E of the CALS Telecommunications Plan[1] discuss near-, mid-, and long-term gateways. This additional effort is in the use of near- and mid-term intelligent and communications gateway technologies to allow use of diverse hardware and software to obtain direct data communications. Gateways facilitate the location, collection, and analysis of data across heterogeneous computer systems and data networks.

Gateway technology will accelerate achieving the planned CALS benefits as they have been stated,[2] including the following:

- Reduced acquisition and support costs through elimination of duplicative, manual, error-prone processes

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[1]LMI Report PL810R1. *Computer-aided Acquisition and Logistic Support Telecommunications Plan.* Doby, John S. Aug 1989.

[2]Office of the Assistant Secretary of Defense (Production and Logistics). Report to the Committee on Appropriations of the United States House of Representatives. *Computer-aided Acquisition and Logistic Support.* 31 Jul 1988.

- Improved quality and timeliness of technical information through the direct coupling to engineering design systems and databases
- Improved responsiveness of the industrial base by the development of integrated design and manufacturing capabilities and by industry networks to build and support weapon systems based on digital product descriptions.

DoD will realize these benefits as the functional integration depicted in Figure 1-1 evolves.

1.2 REPORT ORGANIZATION

This report assesses the components involved in CALS data communications and the status of intelligent and communications gateway efforts. A near- to mid-term candidate joint Military Service gateway strategy is recommended to meet the CALS requirements.

Data communications in the CALS environment serves as the starting point and is discussed in Section 2. The requirements for connecting a variety of systems and for transferring a high volume of data are addressed. The data formats and data transfer protocols used within CALS are summarized. Present and planned communications facilities available to Government users are examined.

Current gateway approaches and implementations are presented in Section 3. Four different types of gateways are reviewed. This discussion provides the baseline for discussing gateway implementations in the CALS environment.

Potential CALS gateway applications are presented in Section 4 based on the requirements developed in the earlier sections. Examples are given of various interconnection schemes to furnish on-line data transfer capability. The gateway functions of command translation, format conversion, analysis, and data network connectivity are explained.

The final section presents the conclusions and the recommendation for a joint Military Service gateway strategy to meet the CALS requirements.

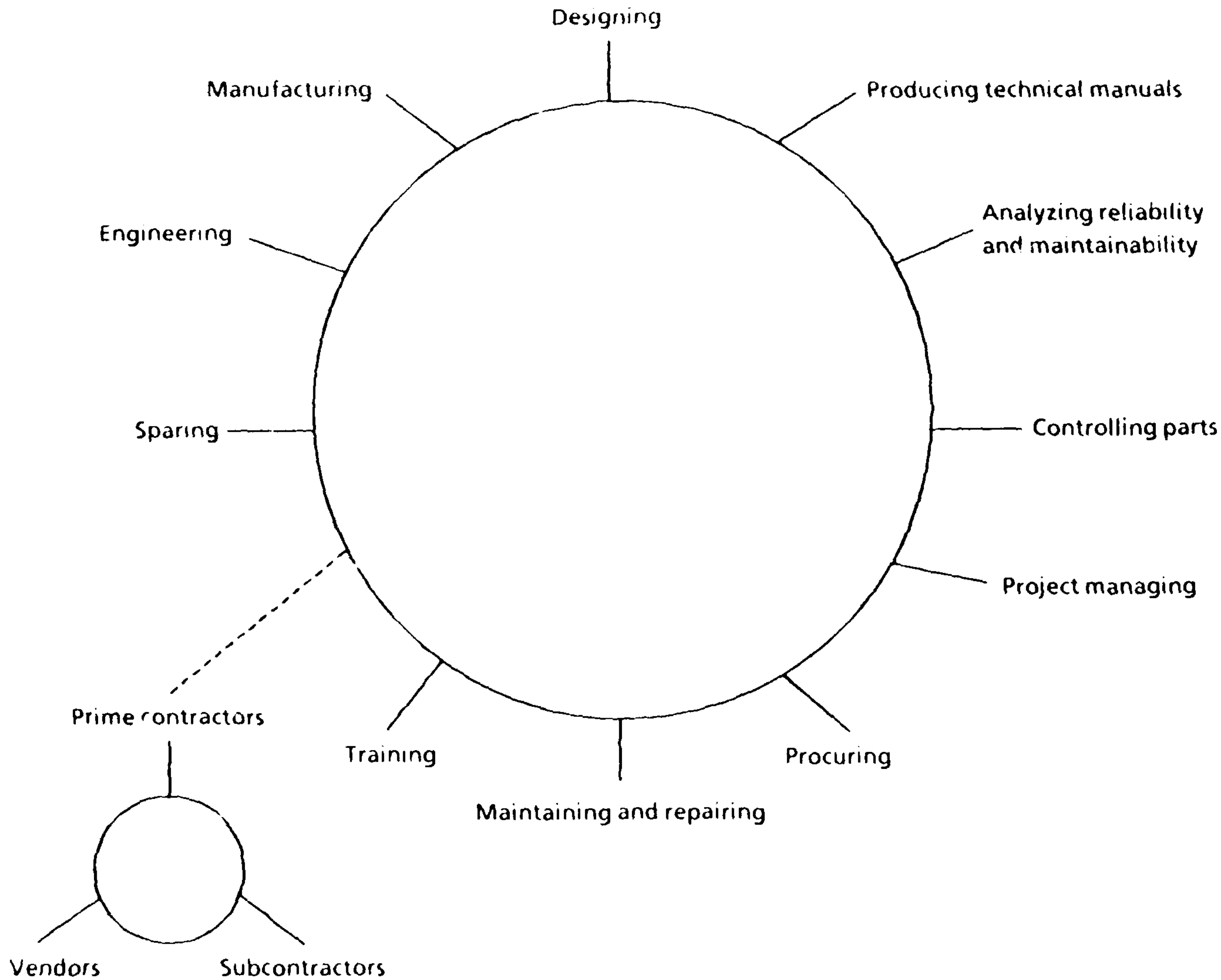


FIG. 1-1. CALS INTEGRATION

SECTION 2

CALS REQUIREMENTS

Gateways in the CALS environment must communicate across a wide variety of computer systems and handle a large volume of information. These needs stem from the three highest priority areas within CALS for DoD systems:

- Architectural planning to link DoD islands of automation and to interface with industry
- Equipping automated engineering data repositories with the capability for digital input to support spares procurement and sustaining engineering
- Providing for digital input to automated publishing and paperless technical manual systems.

2.1 MANDATED FORMAT SPECIFICATIONS

One solution for providing a data communications capability among the Services, agencies, and vendors is to install the same equipment configuration at every location. However, this is not possible since DoD has a large investment in a diversity of installed systems and a desire to maintain competition in industry for future procurements. Instead, DoD has specified a common format for representing the data in Military Standard (MIL-STD)-1840A, *Military Standard Automated Interchange of Technical Information.* This standard specifies a format for the interchange of logistics information between computer systems in the support of weapon systems. Table 2-1 shows the specifications that have been issued for each document type.

DoD established the CALS Test Network (CTN) to test these specifications. The Air Force Logistics Command (AFLC) Architecture and Technology Division and the Lawrence Livermore National Laboratory (LLNL) are performing the tests.

The CTN so far has tested the Standard Generalized Markup Language (SGML) text data and Initial Graphics Exchange Specification (IGES)-formatted graphics data. Text transfer test results indicate that production quality document transfer can be achieved, contingent upon the addition of some automated quality control

TABLE 2-1

CALS SPECIFICATIONS

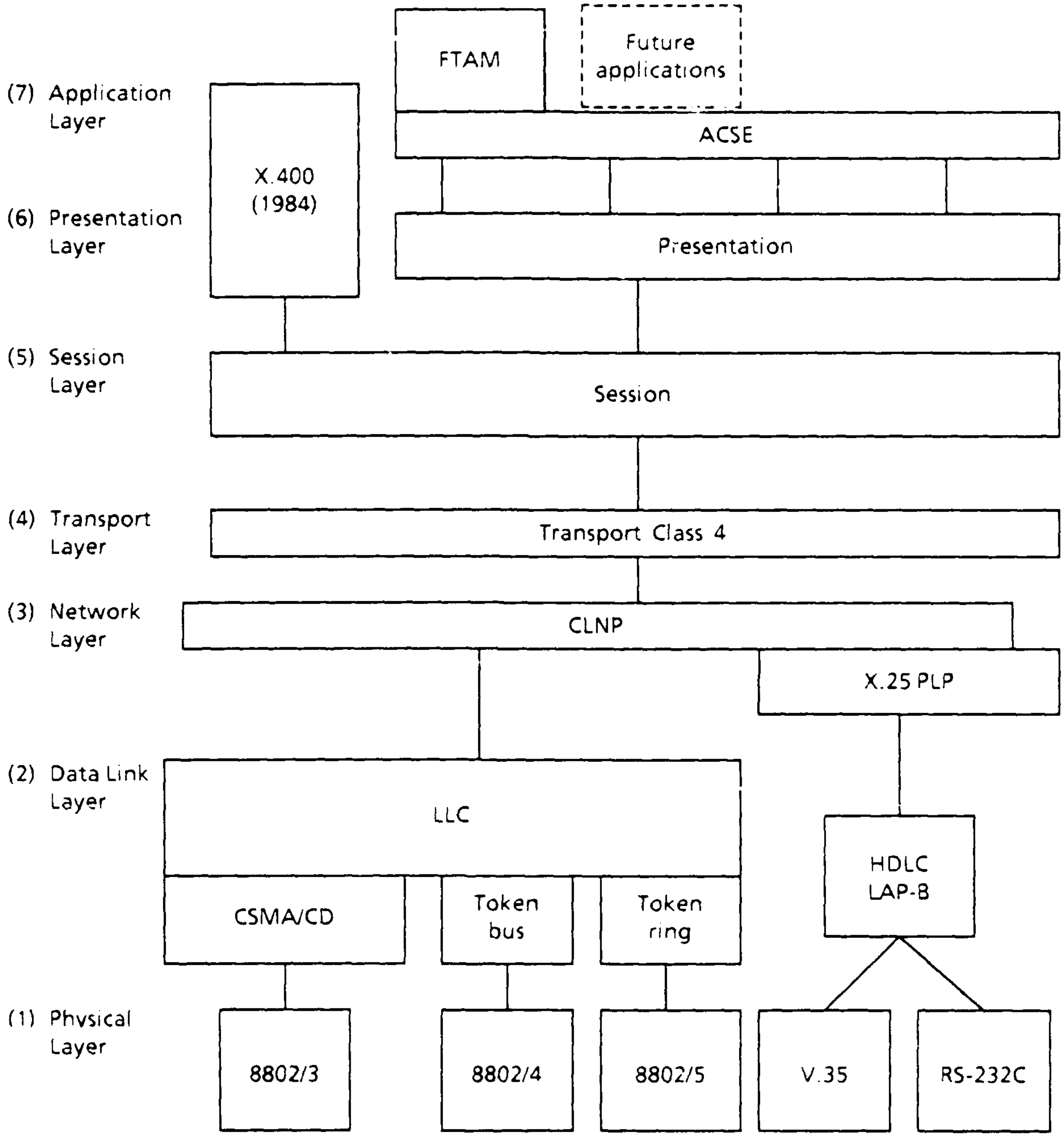
Document type	Specification
Text data SGML – Standard Generalized Markup Language	MIL-M-28001
Computer-aided design (CAD) data IGES – Initial Graphics Exchange Specification	MIL-D-28000
Graphics without CAD data CGM – Computer Graphics Metafile	MIL-D-28003
Data in raster format	MIL-R-28002
Product data PDES – Product Data Exchange Specification	In progress

tools and improved reference documentation. The transfer of graphics using the IGES format worked well except for the type fonts in the text callouts. As a result, the CTN test reports recommend that IGES type font specifications be strengthened, including the alphabet size and set width specifications, and style and emphasis parameters.

Until the CTN thoroughly tests each of the standards and the National Institute of Standards and Technology (NIST) integrates any required updates into the standards, implementers must provide intervening steps. These steps may take the form of specific gateway processors for each type of system or manual intervention to cleanup the documents as they arrive. The gateway would compensate for specific deficiencies or differences in implementation of the standards between two systems.

The specifications cited in Table 2-1 describe how the data are formatted. Other standards are necessary to transmit and receive these data across a variety of machines. Currently in use within DoD is the Transmission Control Protocol/ Internet Protocol (TCP/IP) suite. DoD implementations after August 1990 will use the Government Open Systems Interconnection Profile (GOSIP) suite. Version 1 of the seven-layer OSI architecture is shown in Figure 2-1. GOSIP Version 2 is scheduled for release in late 1989 and will add Virtual Terminal, Office Document Architecture, and Integrated Services Digital Network (ISDN) specifications.

Communications between existing and future systems running the two different protocol suites is one gateway function discussed in Section 3.5.



Notes: FTAM = File Transfer Access and Management; ACSE = Associative Control Service Elements; CLNP = Connectionless Network Protocol; PLP = Packet-Level Protocol; LLC = Logical Link Control; CSMA/CD = Carrier Sense Multiple Access with Collision Detection; HDLC = High-level Data Link Control; LAP-B = Link Access Procedure-Balanced

FIG. 2-1. GOVERNMENT OSI ARCHITECTURE

2.2 HIGH VOLUME AND TRANSMISSION SPEED

The transition to a paperless environment places an increasing demand on the data communications facilities. In addition to text files, CALS data include engineering drawings which result in a large file when represented digitally. An E-size drawing requires more than 8 Megabytes (Mb). Using the file compression techniques specified in MIL-STD-1840A, a 20:1 reduction is achieved. Assuming a 25 percent overhead for handling the transmission, 1,500 drawings would require more than 30 hours to send across a 56 Kilobytes per second (Kbps) line. Sending the same 1,500 drawings would require a little over 1 hour if transmission at 1.5 Megabytes per second (Mbps) were available.

The high volume of data associated with transmitting engineering drawing information drives the requirement for data communications speeds higher than 56 Kbps. High-speed offerings are available in the ISDN and Fiber optic Data Distribution Interface (FDDI) standards. Dedicated networks constructed of 1.5 Mbps lines (T1) or 45 Mbps (T3) lines are also an option.

ISDN implementations provide a set of voice and data services across a single integrated network. Data transmission rates of 64 Kbps, 384 Kbps, and 1.5 Mbps are currently provided. Provisions for broadband service at 45 Mbps and 150 Mbps are under study. ISDN services are now offered in selected regions of the United States.

FDDI is a fiber optic local area network (LAN) that operates at 100 Mbps. Useful applications include interconnecting several high-speed processors located in one computer room or nearby rooms and buildings. Multimode fiber is specified. This reduces the hardware cost by replacing lasers with cheaper light emitting diodes (LEDs) as the light source. FDDI is limited to 2 kilometers (km) between adjacent repeaters, 1,000 physical connections, and a total fiber path of up to 200 km. However, these numbers will vary based on the configuration. Although the FDDI standard is still in draft form, equipment based on a final FDDI standard should be available by late 1989.

Today, long-distance high-speed data transfers are accomplished by installing dedicated facilities. Dedicated lines provide a permanent connection between the two users, even when no data are being transferred. Therefore, they are an option when the traffic between two points is high and reasonably constant. When several

56 Kbps lines between two specific sites are full, moving to a 1.5 Mbps line should be considered.

Data communications facilities available to the Government user are discussed in the next section.

2.3 COMMUNICATIONS FACILITIES

2.3.1 Department of Defense

The two major DoD inter-Service data communications networks are the Defense Data Network (DDN) and the Defense Commercial Telecommunications Network (DCTN). DDN is the mandated data communications network. DCTN is procured through a waiver process. Both are under the control and management of the Defense Communications Agency (DCA).

DDN is a wide-area, packet-switched network that includes about 1,500 hosts with an estimated 50,000 users. The maximum data rate available to users is 56 Kbps. Although the possibility of increasing the data rate across some of the backbones to 1.5 Mbps is under review, there are currently no plans to increase the data rates at the user interface. Because the network uses the TCP/IP and X.25 standards, these protocols must also be resident on each user's system for connection to the network. Everyone uses the File Transfer Protocol (FTP) for file transfers and the Simple Mail Transfer Protocol (SMTP) for electronic mail. All users can send data to (and receive data from) any other user.

DDN users will be billed by their number of network connections and the amount of data sent across each connection beginning in October 1989. The projected tariff for the DDN service is shown in Table 2-2.

DCTN provides switched voice, dedicated voice and data, and video communications for DoD operational support requirements within the United States. These services are provided by American Telephone and Telegraph (AT&T) under a fixed-rate leased services contract that runs through February 1996.

TABLE 2-2

PROJECTED DDN TARIFF

Line speed		Hosts	Terminals
56/50 Kbps	single	$2,200	$300
	dual	2,800	390
19.2 Kbps	single	1,650	300
	dual	2,100	390
9.6 Kbps	single	1,050	300
	dual	1,350	390
4.8 Kbps	single	850	300
	dual	1,100	390
2.4 Kbps	single	700	300
	dual	900	390
1.2 Kbps	single	500	300
	dual	650	390
0.3 Kbps	single	300	300
Dial-up service		7.5 cents per minute	
Traffic charge per kilopacket		Peak hours	Off-peak hours
Precedence 1		$1.35	$1.05
Precedence 2		3.00	3.00
Precedence 3		4.00	4.00
Precedence 4		5.00	5.00

Notes: single = single access to DDN; dual = dual access to DDN; Precedence 1 – 4 = the priority of the user's traffic with Precedence 4 being the highest priority

In addition to terrestrial facilities, DCTN includes satellite communications. The 15 nodal locations contain a digital switch. Nine of these sites have a commercial C-band satellite earth station. An additional 13 nodes are to be offered in FY89. The network configuration is shown in Figure 2-2. By the end of FY89, DCTN should have an estimated 9,600 switched voice access lines, 280 dedicated voice circuits,

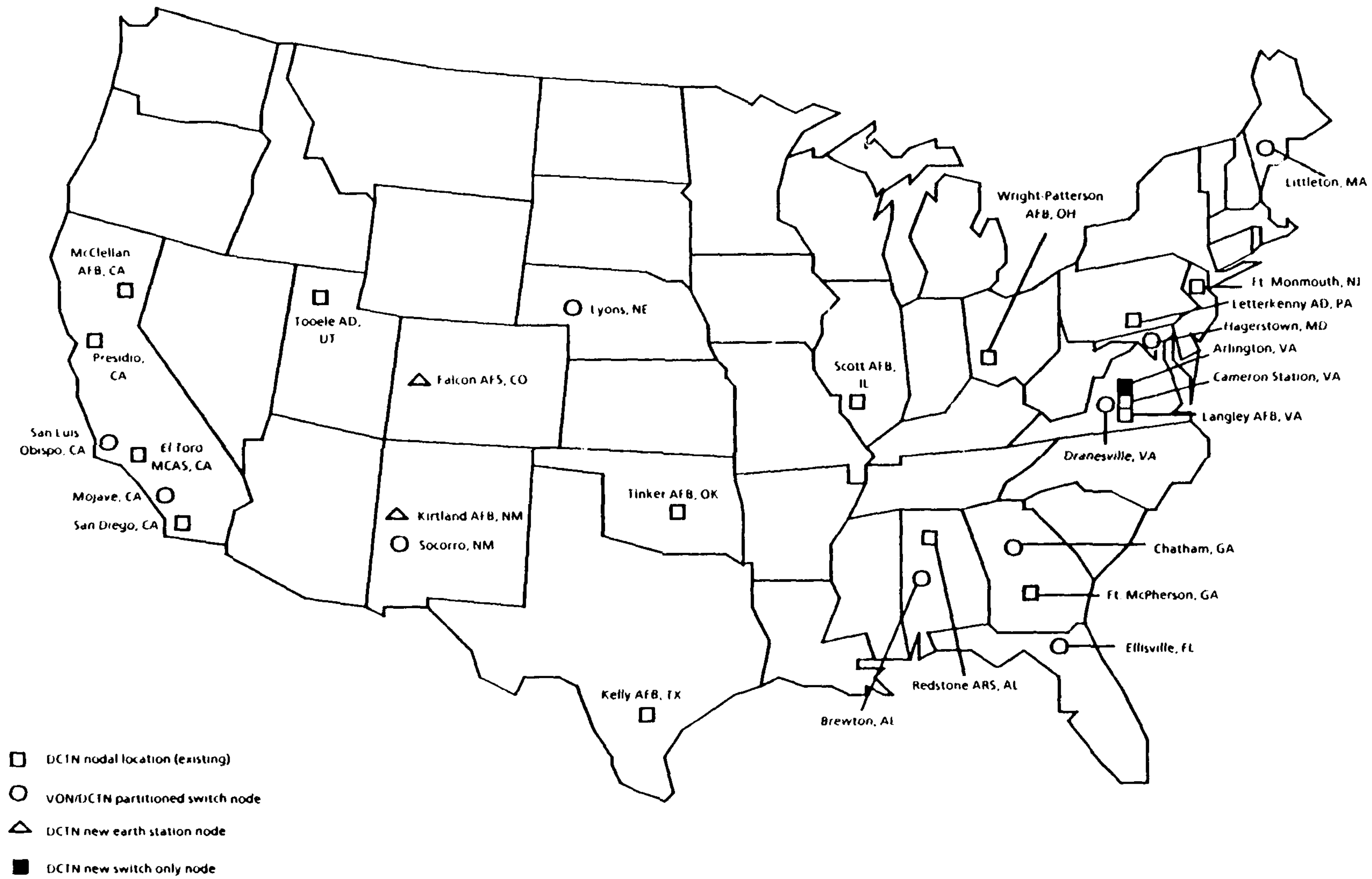


FIG. 2-2. DCTN LEVEL II NODAL LOCATIONS

680 dedicated data circuits (implying 1,360 data users), and 70 video teleconferencing service locations on the network.

DCTN provides nonswitched data services at 4.8 Kbps, 9.6 Kbps, 56 Kbps, and 1.5 Mbps. Because these are dedicated point-to-point services, addressing, routing, and error correction do not involve higher level protocols such as TCP/IP and X.25. Users at each end of the line determine the telecommunications protocols used to send data across DCTN.

The provision time for a DDN circuit is 12 to 24 months. A new circuit on DCTN requires a 3- to 6-month leadtime. DCTN circuit costs are based on the geographical location of the sites connected, rather than a tariffed approach.

2.3.2 Federal Telecommunications System

The General Services Administration (GSA) awarded the Federal Telecommunications System (FTS)-2000 contract in December 1988. The contract award was split 60/40 between AT&T and US Sprint, with AT&T responsible for supporting DoD. The Boeing Company, Computer Sciences Corporation, and Sonicraft Inc. are teamed with AT&T.

FTS-2000 services will be available in early 1991 or sooner and will include switched voice service, switched data service, switched digital integrated service, packet-switched service, electronic mail, video transmission service, and dedicated transmission service. The switched data service will provide synchronous, full duplex, digital circuit-switched service at 56 Kbps and 64 Kbps. The dedicated transmission service provides the same service on a continuous basis, plus full T1 facilities. The integrated services will come on line with the availability of ISDN. Under ISDN, all the services listed above – voice, data, and video transmissions – are combined on a single network. The allocation of each circuit's capacity is configured dynamically by the users and is a part of the call setup.

SECTION 3

CURRENT GATEWAY APPROACHES AND IMPLEMENTATIONS

This section reviews a sampling of current gateway approaches to achieve connectivity. These examples provide a background to discuss the methods available for CALS. The first example is the Logistics Information Exchange (LINX) as proposed by the Defense Logistics Agency (DLA). It is based on gateway technology that was developed at LLNL and is now being marketed and supported by Control Data Corporation (CDC). This technology is also used in AFLC's Logistics Data Information System (LOGDIS), the Air Force Aeronautical Systems Division's Central Datacomm System (CDS), and is offered as an option under the Air Force's Standard Multiuser Small Computer Requirements Contract (SMSCRC) with AT&T. The second example, Fast, is a product developed by the University of Southern California's Information Sciences Institute (USC/ISI). It has been used for the connectivity required in automated electronic parts ordering. The next two examples are the Naval Supply Logistics Network (NLN) and the Defense Automatic Addressing System Office (DAASO) network. Both networks provide for data transmission among a variety of systems. The final example describes gateway development efforts under way at NIST supporting the transition from the DoD protocol suite to the GOSIP. The NIST gateways should allow file transfer and electronic mail between the two protocols and coexistence of the two on the same network.

3.1 LOGISTICS INFORMATION EXCHANGE

DLA is pursuing a gateway effort in the LINX program. The goal of LINX is to provide an agency and vendor interface for Electronic Data Interchange (EDI) communications. LINX will incorporate the capabilities of the Technology Information System Program (TISP)/Intelligent Gateway developed by LLNL. This gateway is now being marketed and supported under the trade name of ASCENT by CDC, who worked in conjunction with LLNL. Features of the gateway include

- Support for multiple terminal types and personal computers (PCs)
- Connectivity to multiple noncompatible hosts

- Auto log-in to multiple noncompatible hosts
- Capability to download, reformat, manipulate, and integrate data.

A phased approach is planned. The initial step integrates the current vendor interfaces [Paperless Order Processing System (POPS) and SAMMS[1] Procurement by Electronic Data Exchange (SPEDE)] into an automated system. Near-term service capabilities would include access through DDN, dial and dedicated services, and Ethernet LANs. It would support negotiated EDI formats, American National Standards Institute (ANSI) X.12 formats, and valued-added networks (VANs). In later stages, LINX would transition toward emerging standards, including GOSIP. Because many communications facilities use the TCP/IP suite today, TCP/IP would remain as an option when GOSIP becomes available.

3.2 FAST

Fast (sometimes called "Fast Broker") is a computerized system for the automatic purchasing of standard electronic parts. It was developed at USC/ISI under the sponsorship of the Defense Advanced Research Projects Agency (DARPA) and AFLC. Users communicate with Fast by electronic mail to request technical information and quotes. Customers can place orders that are filled by overnight shipping. Customers then reimburse Fast for the purchase.

The Fast system's connection to on-line vendors is depicted in Figure 3-1. A Request for Quotation (RFQ) generates an RFQ message to all on-line vendors for that product. The user receives the vendors' quotes usually in minutes. Technical information and parts equivalence information can also accompany the vendors' quote. When necessary, Fast also contacts vendors who are not on line. The Fast electronic connection meets the ANSI X.12 standards.

Fast resides at USC/ISI on the ARPANET/MILNET/INTERNET[2] network. Users send and receive messages by electronic mail via Telemail and MCI Communication Corporation Mail.

[1]Standard Automated Materiel Management System.

[2]Advanced Research Projects Agency Network/Military Network/INTERNET.

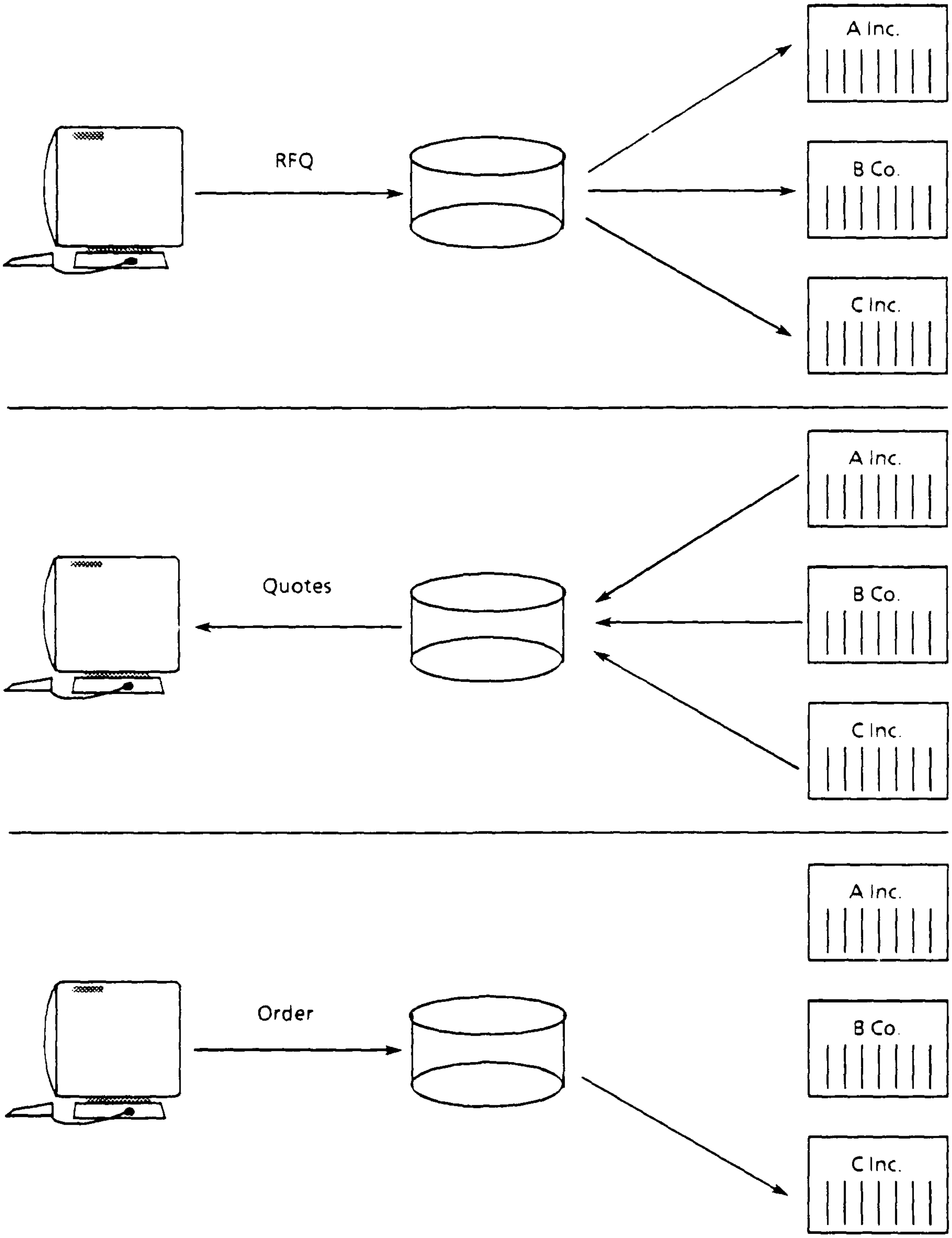


FIG. 3-1. FAST

DLA is testing Fast by using it as a vendor on the SPEDE system at the Defense Electronics Supply Center (DESC). SPEDE uses the X.12 format and accesses Fast over a dial-up line.

3.3 NAVAL SUPPLY SYSTEMS COMMAND'S LOGISTICS NETWORK

The Naval Supply Systems Command's (NAVSUP) NLN provides telecommunications, interactive processing, front-end processing, and terminal concentrator capabilities. The telecommunications feature provides connectivity for the inventory control points (ICPs), stock points, and specific users of logistics information. Hardware has been installed at 39 sites, with 6 more planned for 1989, as shown in Figure 3-2. Currently, NLN supports an estimated 10,000 users. Gateways are in place or planned for access to the Defense Logistics Agency Network (DLANET), Defense Automatic Addressing System (DAAS), Military Airlift Command (MAC) Advanced Transportation Control and Movement Document System (ATCMDS), Inventory Locator System (ILS), Technical Logistics Reference Network (TLRN), and Haystack.

Tandem computers serve as the gateways. Resident on the Tandem are flat file transfer capabilities for accessing other Tandems and other vendors' equipment, including IBM, UNIVAC, Burroughs, and Honeywell. As an example, the Tandem computer gateway to DLA is running a Systems Network Architecture (SNA) to 3270 Bisync conversion to communicate with the COMM TEN on DLA's side.

Dedicated contingency lines, as shown in Figure 3-3, rather than DDN are currently in use as the backbone for NLN. The exception is for the OCONUS[3] sites in Yokosuka, Japan; Subic Bay, Philippines; and Guam which are accessed through DDN. The dedicated lines primarily operate at 9.6 Kbps to 19.2 Kbps.

Plans include a gateway between the proprietary Tandem mail protocol and the DoD SMTP for communications with European customers and transition to the OSI protocols when they become commercially available.

[3]Outside of the Continental United States.

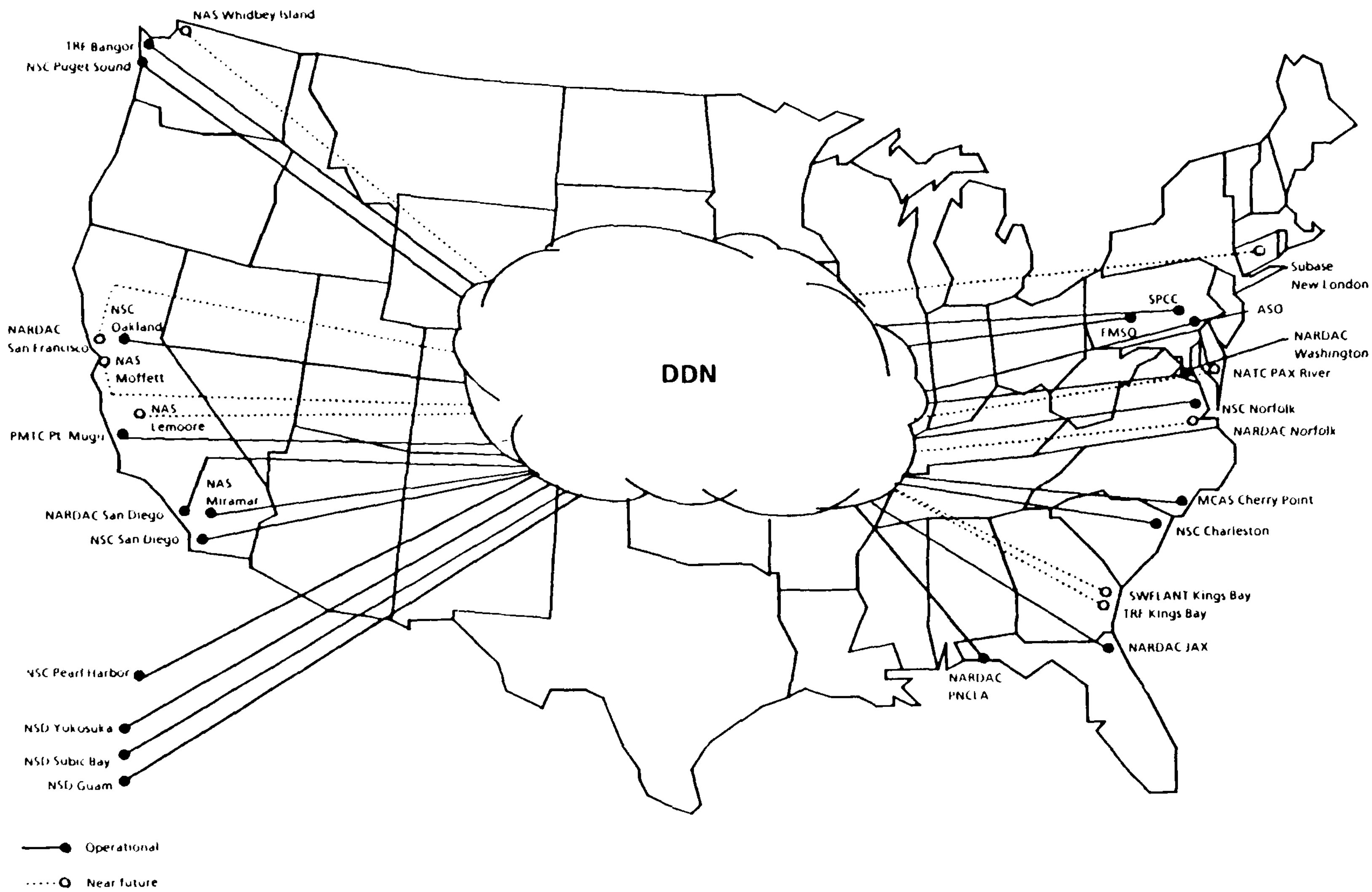


FIG. 3-2. NLN DDN CONNECTIVITY

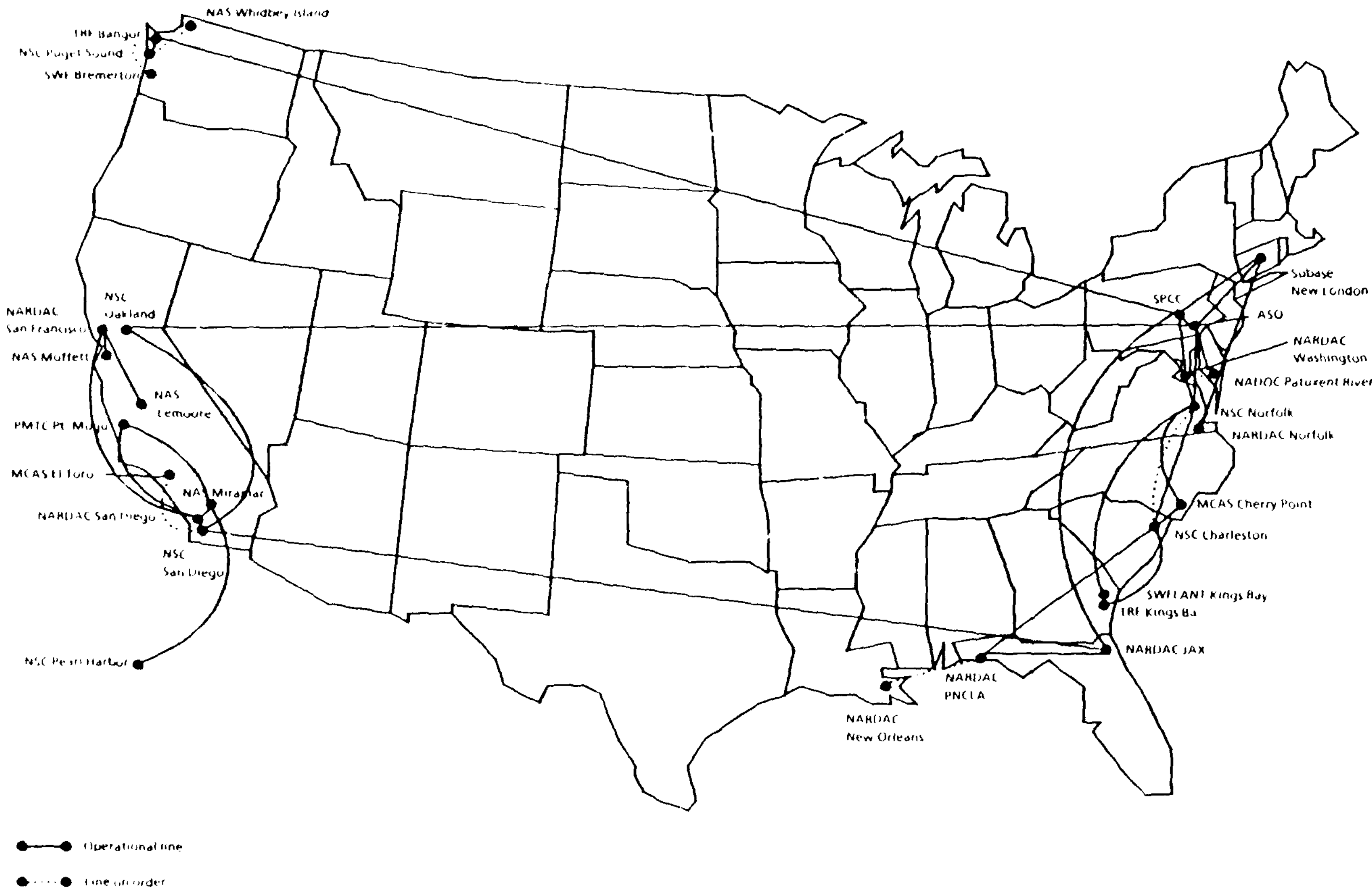


FIG. 3-3. NLN NETWORK CONNECTIVITY

3.4 DEFENSE AUTOMATIC ADDRESSING SYSTEM

DAAS receives and routes worldwide logistics traffic, processes logistics documents, generates activity reports, publishes address directories, and maintains large-scale databases. It also serves as a central facility to implement new DoD logistics procedures. DAASO resides within DLA.

DAASO operates from two sites; one in Dayton, Ohio, and the other in Tracy, California. Each site uses CDC, Gould, and Zenith computers. CDC 1700 systems are used as the front-end communications processors to receive and transmit Automatic Digital Network (AUTODIN) message traffic. Each of the two DAASO sites and the associated AUTODIN Switching Centers (ASCs) are linked by 4.8 Kbps lines as shown in Figure 3-4. The messages are formatted as established by Joint Army, Navy, Air Force Procedures (JANAP) 128 AUTODIN Operating Procedures. DAASO in Dayton, Ohio, is also the central point for interfacing with the International Logistics Communications System (ILCS). The two are connected on a dial-up basis. The systems are in use 24 hours a day, 7 days a week, processing more than 80 million transactions each month.

DAASO is currently implementing an Automatic Data Processing Equipment (ADPE) Replacement Program plan to support current and future levels of service to input subscribers. After updating, a variety of transmission paths will be available including AUTODIN, DLANET, NLN, DDN, ILCS, dial-up lines, and dedicated private lines.

3.5 OSI/DoD NETWORK INTEROPERABILITY

GOSIP Federal Information Processing Standard (FIPS) 146, released in August 1988, mandated that network procurements after August 1990 conform to the specified OSI standards. DCA produced a transition strategy for moving from the DoD protocols to OSI. The plan calls for coexistence of OSI and DoD protocols on shared networks and the capability to interoperate between the two protocol suites. With these two capabilities, DoD will not have to attempt a sudden and complete switchover from TCP/IP to GOSIP protocols. The switchover can proceed over a period of 7 to 10 years.

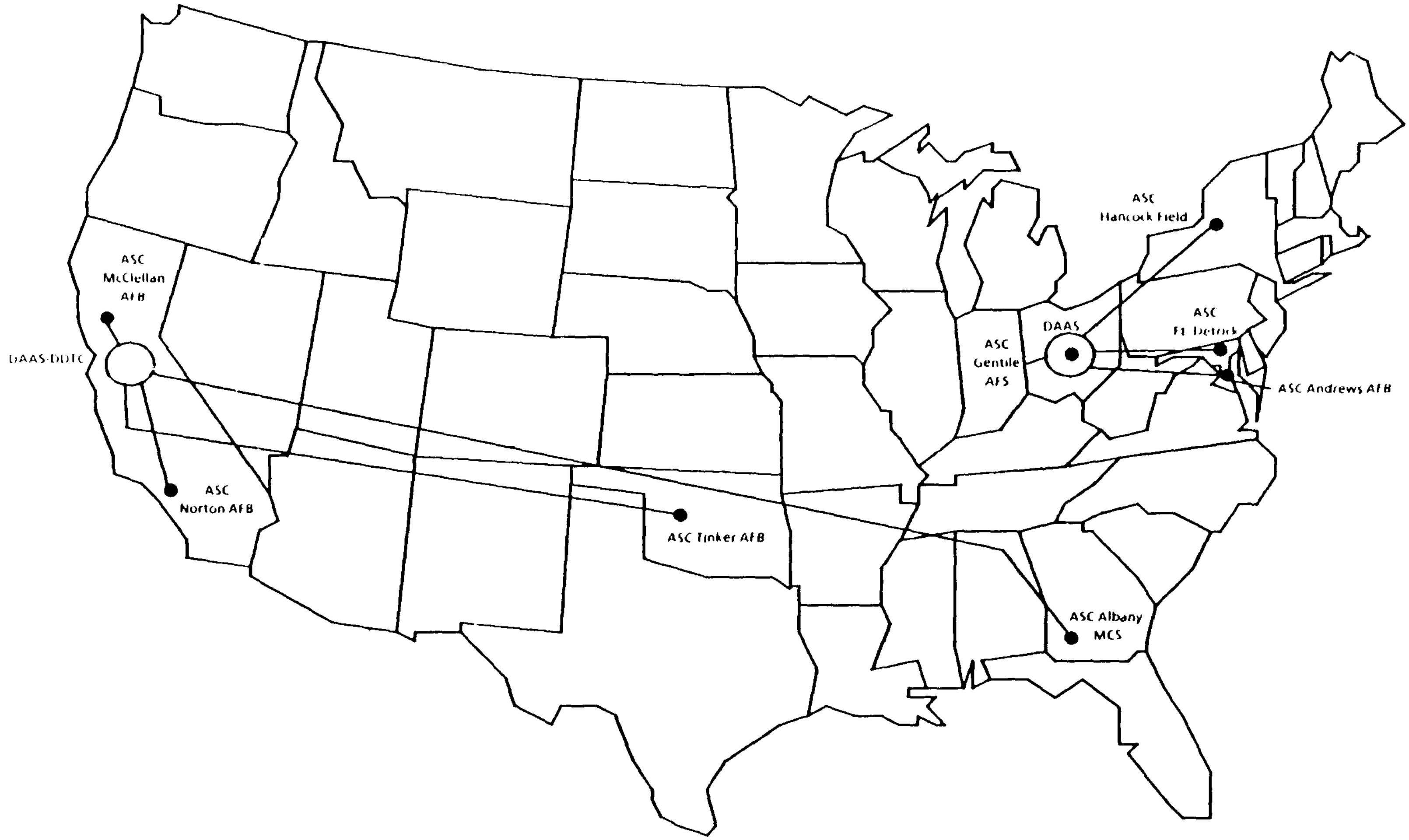


FIG. 3-4. DAAS AND AUTODIN SWITCHING CENTERS

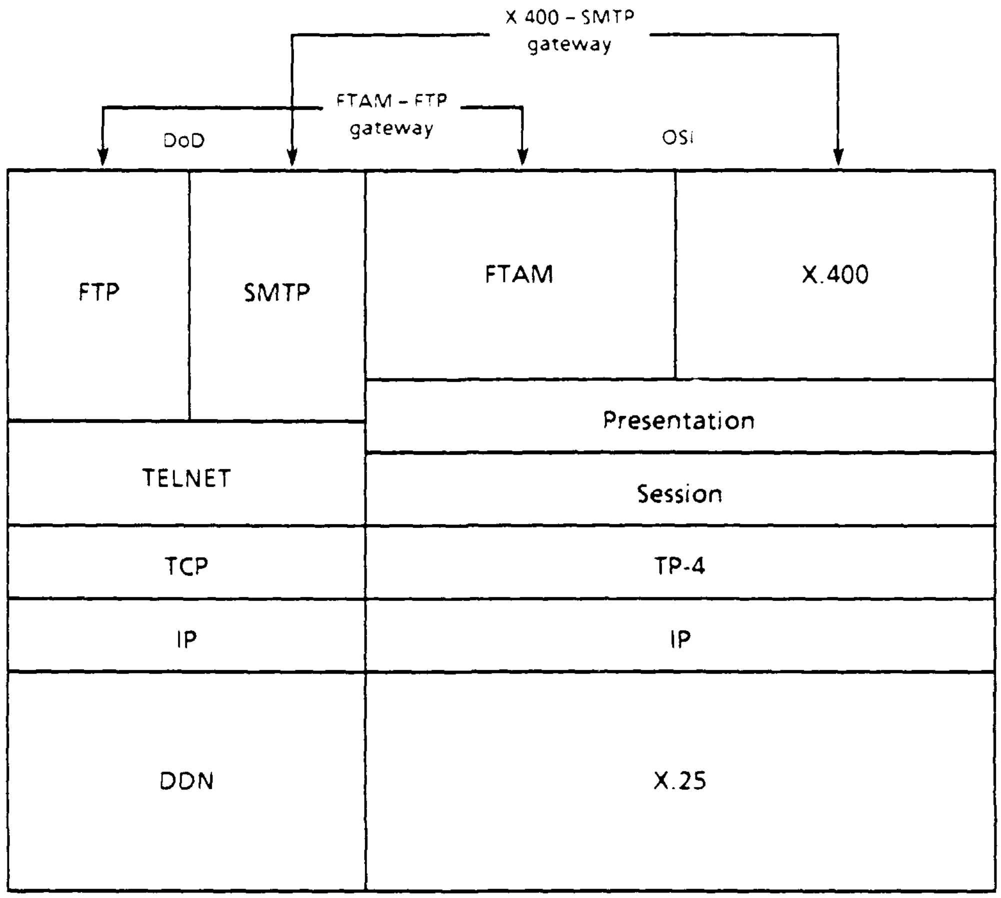
Several gateways are planned for the initial steps in transitioning from the current DoD protocol suite over to those specified by GOSIP. Interoperability will be achieved by implementing File Transfer Access and Management (FTAM)/FTP and X.400/SMTP gateways in the Application or seventh layer of the OSI model. A Connectionless Network Protocol/Internet Protocol (CLNP/IP) gateway is under development to aid coexistence. The CLNP/IP gateway resides above the Network or third layer to serve as an internet gateway. Both types of gateways are discussed in more detail below.

3.5.1 Application Layer Gateways

Application Layer gateways allow users to communicate across the different protocol suites. DoD tasked NIST in 1986 to develop two gateways for use between OSI and TCP/IP. The prototype FTAM/FTP gateways for file transfer and X.400/SMTP gateways for electronic mail are currently under test on the Open Systems Interconnection Network (OSINET). Developed on a Digital Equipment Corporation MicroVax II, these two application gateways will be released as a part of the next Berkeley UNIX operating system version in December 1989.

DCA plans to provide the file and mail gateways on the DDN. The gateways are dual protocol hosts in that they implement the full OSI and DoD protocols. The gateway software translates from one application to the other as shown in Figure 3-5. The application gateways will be placed on the DDN as shown in Figure 3-6. A call from an OSI host to a DoD host would be routed through the application gateway for the translation. However, to reduce the congestion across the DDN, the gateway software will also be made available through a Berkeley UNIX release. Then, DoD users can implement a gateway on their own LANs as shown in Figure 3-7. With this capability resident locally, fewer calls across the DDN will be necessary. The calls to the gateway will be made across the LAN, which is usually operating at much higher speeds than the DDN. DCA recommends for all but the occasional user that the OSI/DoD gateways be placed on users' LANs. Otherwise, the recurring need to access the gateways on the DDN will produce a bottleneck in users' data communications.

The Application Layer gateway allows a transition period for updating TCP/IP systems to the GOSIP. However, users will be motivated to change their TCP/IP systems which must communicate with the GOSIP compliant systems coming on line, rather than relying on the gateway. The gateway slows communications, since it



Notes: TCP = Transmission Control Program; TP-4 = Transport Protocol Class 4.

FIG. 3-5. GATEWAY ARCHITECTURAL MODEL

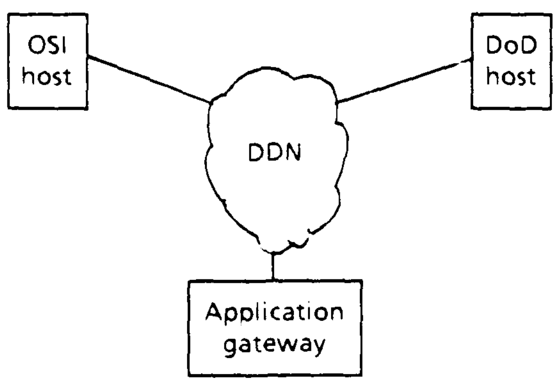


FIG. 3-6. DDN-BASED GATEWAY

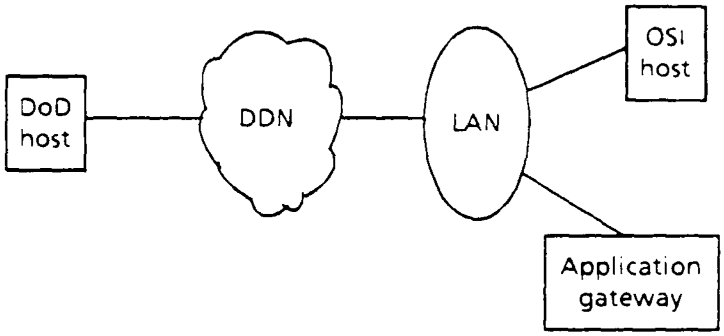


FIG. 3-7. LAN-BASED GATEWAY

must unpackage the TCP/IP data, map it between the different mail or file transfer protocols, and repackage it according to GOSIP.

3.5.2 Connectionless Network Protocol/Internet Protocol

CLNP is the OSI counterpart of the DoD IP at the Network Layer. CLNP provides the means to tie together subnetworks based on the different lower layer technologies defined by GOSIP. To route data across the different subnetworks, unique names are used to identify each object in the network. OSI name and address attributes will be registered through NIST.

To interconnect wide-area networks (WANs) or LANs that may have both DoD and OSI hosts, a dual gateway is required. The dual gateway would provide both the CLNP and IP and is located as shown in Figure 3-8. The gateway does not translate from one protocol to the other, but rather lets both coexist on the same network interconnection. The CLNP portion is required to internetwork the OSI hosts. The IP half allows internetworking of the DoD protocol hosts.

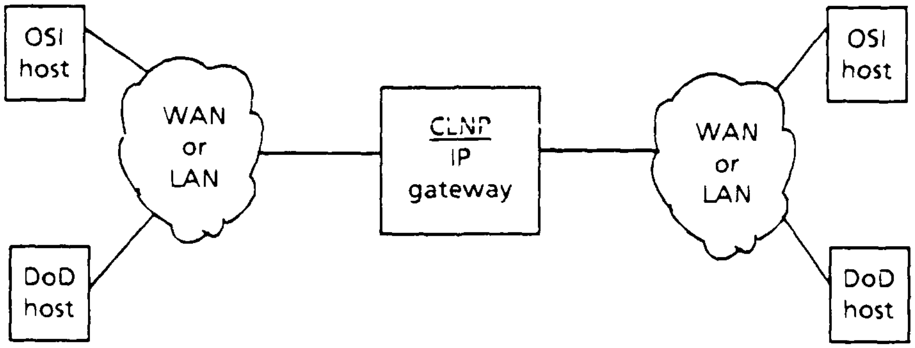


FIG. 3-8. CLNP/IP GATEWAY

SECTION 4

POTENTIAL CALS GATEWAY APPLICATIONS

Gateways can provide access for current and future systems through cost-effective, secure, high-speed data communications networks – both commercial and Government. This access, while systems and standards are evolving, provides a direct data connection where the CALS requirements warrant one.

Potential CALS scenarios are based on the different combinations of formats, protocols, and networks presented in Table 4-1. For example, it may be desirable to send drawings between two particular locations. The gateway at each end might support transferring drawings in the IGES format by using the GOSIP protocol FTAM across a high-speed WAN. This and other combinations allowing the transfer of an IGES-formatted drawing are shown in Figure 4-1.

TABLE 4-1

CALS ELEMENTS

Information format	Text: SGML Drawings: IGES/raster/CGM Product data: PDES
File Transfer Protocol	FTP or FTAM
Network	LAN, WAN, or combination of the two

Notes: CGM = Computer Graphics Metafile; PDES = Product Data Exchange Specification

The combinations are varied and implementation can prove difficult. Gateways serve to fill in the gaps between dissimilar systems. Sending information in the SGML or IGES format requires intervention to reformat the data and to make implementation decisions where the standards are ambiguous. Compliance with the standards varies from vendor to vendor. The range of file transfer protocols is supported to varying degrees on different systems. Higher speed LANs and WANs are available; however, gateways are needed to combine them for end-to-end connectivity.

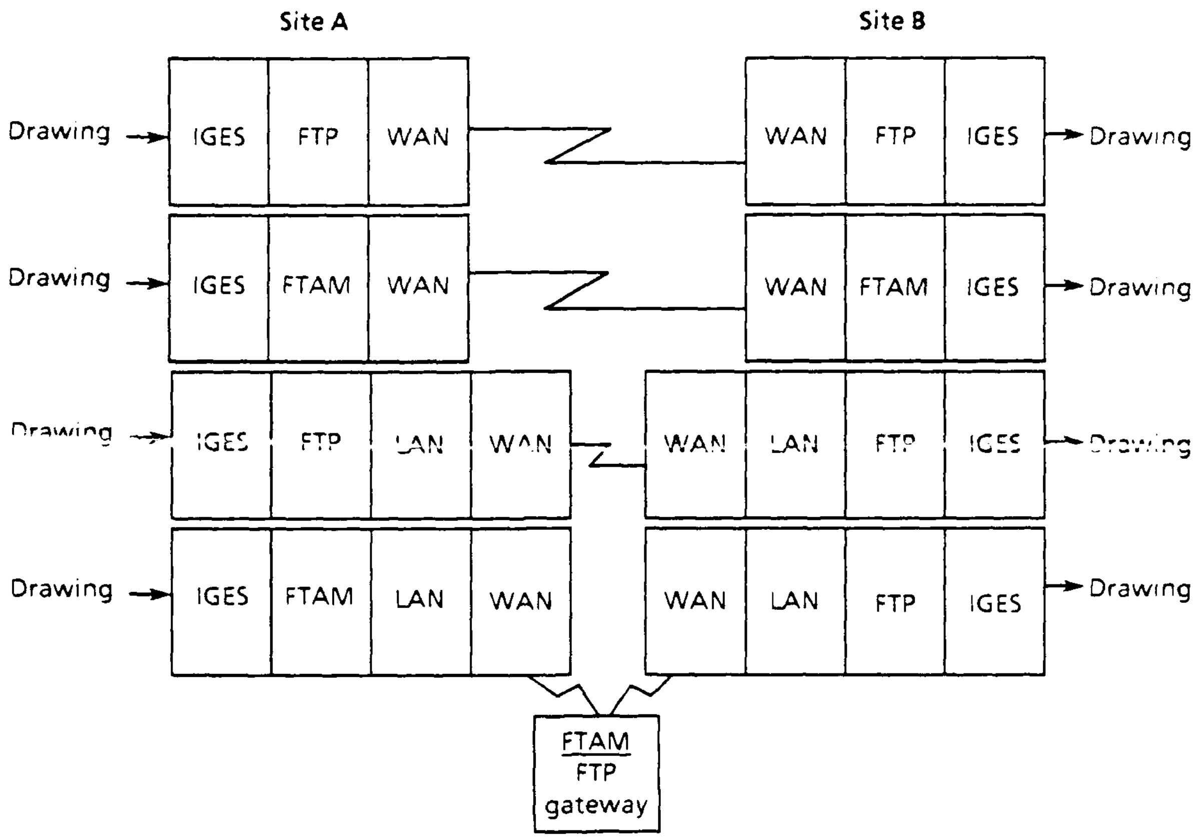
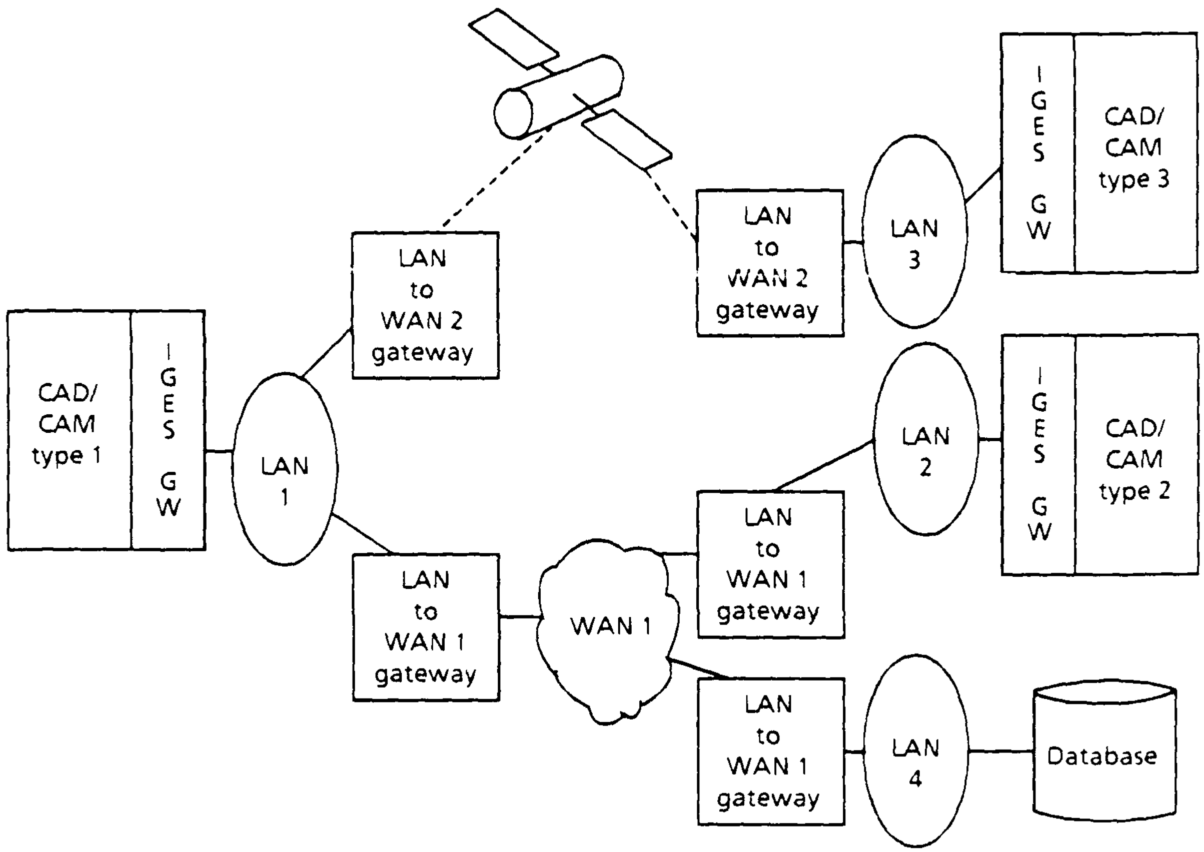


FIG. 4-1. ELECTRONIC TRANSFER OF DRAWINGS IN IGES FORMAT

A gateway in a CALS network should not be viewed as a single computer system that handles both the intelligent and the communications facilities. While this may indeed be the case in some instances, it is also possible that the gateway functions may be distributed. Take, for example, computer-aided design/computer-aided manufacturing (CAD/CAM) systems at two different vendors. The vendors need to share their drawings to integrate their designs efficiently. To do this, a gateway at each end must provide a common data format for the drawings and a path from each vendor's LAN to the shared high-speed data connection. A distributed gateway approach would use an IGES translator designed by each CAD/CAM manufacturer for their system. This translator would reside on each CAD/CAM system, providing the common data format required. If each system resides on a different type of LAN, the communications feature of the gateway would reside as a separate user on its LAN. As a separate user, it would have both the LAN and the WAN interfaces and file transfer protocols of each. The gateway features of translation and communications are separated by function as shown in Figure 4-2. Using this modular approach, if a third vendor were to be added, the first two vendors need only add the communications gateway features required to connect to the new member. The translation portion would remain the same.



Note: GW = gateway

FIG. 4-2. DISTRIBUTED GATEWAY FEATURES

In the example shown in Figure 4-2, the IGES translator is designed specifically for each manufacturer's CAD/CAM system and runs only on its system. For less complex reformatting, such as creating SGML-formatted files from text files, the SGML capability may be resident with the communications gateway as shown in Figure 4-3. The benefit of this design is that a translator, located in one place, can support input from a large variety of word processing systems. Using a high-speed shared gateway greatly reduces its support and maintenance costs. When an update is required, only the gateway has to be taken out of service.

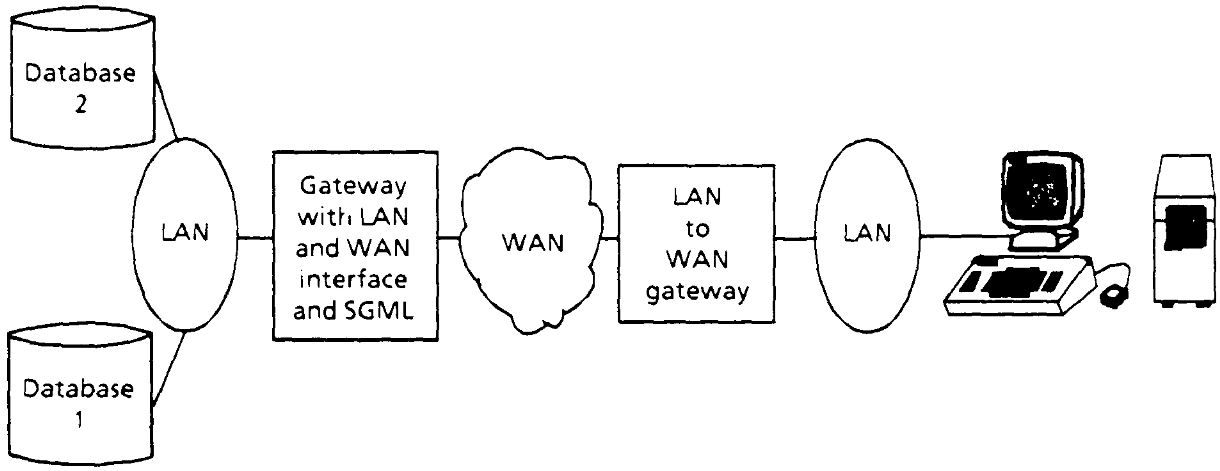


FIG. 4-3. CENTRALIZED GATEWAY FEATURES

Simple translations such as SGML reformatting can also be a value-added service provided on the WAN. Value-added services provided by WANs include error checking and possibly correction, speed matching between users, and temporary storage of undeliverable data. To add translation capability, it must be uncomplicated and preferably be performed at the network node where the user connects into the WAN. If both of these conditions are met, the impact of the slower speeds on a WAN compared to a LAN will be reduced. The benefits gained from having the SGML translation on the WAN include sharing the gateway resources across a larger group of users, billing based on usage, and having centrally implemented and maintained facilities. Placing the capability in a gateway on the LAN, as depicted in Figure 4-3, is appropriate when the communications gateway on the LAN provides a more general platform for integrating SGML than the dedicated WAN node. Communications gateways are often built upon general purpose computers with both a local and WAN interface. It would be easier to add SGML translation to such a system rather than modify or add to the dedicated systems that make up a WAN node.

For interactive sessions, the user at a terminal logs on to the remote system and searches for the desired information. Once the information is found, the user downloads a copy to his/her own system. Intelligent gateway features must include automatic remote log-on and command translation capabilities in this case. The command translation transforms the user's generic query or request into the specific commands for the system being accessed.

When used in a noninteractive mode, the gateway transmits user requests to the remote system. Upon receiving the message, the remote system prepares the requested document, such as a manual or list of publications, for transmittal back to the user. In another scenario, documents will be transferred on a prescheduled basis between systems in one or both directions without the need for user involvement.

To send a document in either the interactive or noninteractive mode, the intelligent gateway must be able to analyze the input to produce the desired output. Using the SGML example above, the text file sent to the gateway may have been stored in the American Standard Code for Information Interchange (ASCII) format or in a specific word processing format. If the format of the source is known, the document can be reformatted into SGML and be ready for transmission. The next step, determining the path to the destination user, requires a directory capability. The desired user or destination is matched with its connectivity constraints. For instance, the directory may list the user's electronic mailbox on DDN. The SGML document can then be delivered using the correct protocol for the facilities where the user is located. Throughout the process, the gateway selects from multiple possibilities to make a useful connection with the distant user.

Table 4-2 depicts the primary locations where the command translation, format conversion, network routing, protocol conversion, and analysis can occur. Concentrating the capabilities as discussed in the SGML and IGES examples minimizes the impact to the systems involved.

TABLE 4-2

CAPABILITY MATRIX

Primary location	Command translation	Format conversion	Network routing	Protocol conversion	Analysis
Sender	x	x	x		x
Receiver		x			x
LAN		x	x	x	x
WAN		x	x	x	

SECTION 5

CONCLUSIONS AND RECOMMENDATION

5.1 CONCLUSIONS

The key points governing the implementation of gateways in the near- and mid-term time frames are summarized below:

- All CALS data communications solutions must be done in accordance with the GOSIP. At the same time, the ability to communicate through the existing TCP/IP protocols must be preserved. TCP/IP systems will probably remain in use for the next 7 to 10 years for portions of CALS.

- For other than occasional usage or simple text file transfers, gateway functionality should be placed on the user's LAN or within the host computer. This approach provides greater data carrying capacity to the user than placing the gateway on a WAN. Transmitting data among different networks to reach the user's destination may still require internetworking facilities such as those provided by the NLN and DAAS.

- SGML for sending text is the simplest CALS specification to implement. Computer Graphics Metafile (CGM) and raster graphics follow and are necessary for the graphics that accompany the text. IGES is third, since ambiguities remain. The Product Data Exchange Specification (PDES) is still under development.

- CALS implementation would be accelerated by quick resolution of the ambiguities in CALS data format standards as uncovered by the CTN. Refining these standards will reduce the need for gateways tailored to particular implementations of each CALS standard.

- Intelligent gateway development to date has been based on lower volumes of data than envisioned under CALS. Telecommunications planners must recognize the high volume of potential CALS data traffic; the IGES files associated with engineering drawings being particularly significant.

- Each Service and agency must provide a traffic profile of its anticipated CALS data flow. Government network planners need to factor these requirements into their data communications planning along with the EDI and MODELS efforts. DoD data network facilities are primarily operating at 9.6 Kbps and 56 Kbps. The CALS traffic profiles will provide the rationale for higher data transfer rates.

5.2 RECOMMENDATION

The OSI/DoD gateway technology developed by NIST will be a required stepping stone at many facilities. In addition to the need to access computer systems through both the OSI and DoD protocol suites, CALS data transfers are made in specific formats. Gateways are required in the interim to translate the output of current systems into these formats. Once the data have been formatted correctly, they can be sent on magnetic tape, optical disk, or through a data communications network. For the data network connections, a gateway may be required for entering a higher speed network.

To meet these requirements, we recommend implementing gateway technologies in the following order:

- OSI/DoD gateway
- SGML text format
- CGM and raster drawing formats
- Access to data networks operating at 1.5 Mbps
- IGES drawing format
- PDES.

The OSI/DoD gateways are listed first based upon our first conclusion. These gateways will be available as a part of the public domain Berkeley UNIX release by the end of 1989. As DCA recommends, this capability should be added locally to increase efficiency.

SGML is listed next since the specification has proven the most successful in testing on the CTN and is the simplest to implement. A gateway allows the transition from transmitting data on magnetic tape or optical disk to having a data network connection between users. A CALS SGML gateway should have the following capabilities:

- Translation to SGML from ASCII and the most common proprietary text file formats. A commercial off-the-shelf (COTS) product should be used, with the requirement that it keep in step with the emerging Portable Operating System Interface for UNIX (POSIX) profile from NIST. Translation may initially be a two-step process. The first step would be a software package for translation among the various text file formats. The second step would be the translation from a specific format such as ASCII to SGML.

- Local communications over an Institute of Electrical and Electronic Engineers (IEEE) 802.3 LAN for implementations where the SGML gateway process is not embedded in the local host.
- Distant communications connectivity at 56 Kbps with the option to increase to 1.5 Mbps data rates. The TCP/IP should be used at first, with incorporation of COTS GOSIP products as they become available.

An example platform for a UNIX-based SGML translator is the AT&T bundled product proposed under the Air Force's SMSCRC. It offers each of these features, except the translation from ASCII format to SGML. The intelligent gateway ASCENT, included as an option, provides automated log-on and connectivity. The KEYpak software option translates among the ASCII and 24 common text formats. The DDN WAN and IEEE 802.3 LAN interfaces furnish the distant and local connections.

CGM and raster capabilities permit transferring illustrations. Added after SGML, they would permit the digital transmission of technical manuals. The CGM and raster gateway capabilities would reside on the host system where the illustrations are produced or scanned into the system.

Before moving on to IGES, which is the next format in order of increasing difficulty, high-speed data network access should be acquired. Data network access at 1.5 Mbps is available to DoD today through dedicated network facilities. Although the higher speed is not widely used, once CALS users start transmitting documents in SGML, CGM, and raster format, they will soon outgrow the capacity provided by 56 Kbps. This will become more apparent as each of the Military Services publishes its anticipated CALS data communications requirements. COTS hardware is available to connect the dedicated lines into local networks such as IEEE 802.3 to provide the communications gateway. ISDN connectivity off the LAN should be added as COTS products become available.

The level of compliance with IGES should be reviewed thoroughly in future CAD/CAM procurement. The translation for current proprietary CAD/CAM formats into IGES is probably handled best by vendors' products for their host machines. The translators are highly specialized for each vendor's product. Once the data are in an

IGES format, following the recommendations made above for SGML and high-speed data network access will complete the required gateway functionality.

PDES data transfer capability should be integrated as COTS products become available. The first translation capabilities will be located with the application as with IGES. The communications gateway features can then be distributed onto the LAN.

GLOSSARY

ADPE = Automatic Data Processing Equipment

AFLC = Air Force Logistics Command

ANSI = American National Standards Institute

ARPANET = Advanced Research Projects Agency Network

ASC = AUTODIN Switching Center

ASCII = American Standard Code for Information Interchange

ATCMDS = Advanced Transportation Control and Movement Document System

AT&T = American Telephone and Telegraph

AUTODIN = Automatic Digital Network

CAD/CAM = computer-aided design/computer-aided manufacturing

CALS = Computer-aided Acquisition and Logistic Support

CDC = Control Data Corporation

CDS = Central Datacomm System

CGM = Computer Graphics Metafile

CLNP = Connectionless Network Protocol

COTS = commercial off-the-shelf

CTN = CALS Test Network

DAAS = Defense Automatic Addressing System

DAASO = Defense Automatic Addressing System Office

DARPA = Defense Advanced Research Projects Agency

DCA = Defense Communications Agency

DCTN = Defense Commercial Telecommunications Network

DDN = Defense Data Network

DESC	=	Defense Electronics Supply Center
DLA	=	Defense Logistics Agency
DLANET	=	Defense Logistics Agency Network
DoD	=	Department of Defense
EDI	=	Electronic Data Interchange
FDDI	=	Fiber optic Data Distribution Interface
FED-STD	=	Federal Standard
FIPS	=	Federal Information Processing Standard
FTAM	=	File Transfer Access and Management
FTP	=	File Transfer Protocol
FTS	=	Federal Telecommunications System
FY	=	fiscal year
GOSIP	=	Government Open Systems Interconnection Profile
GSA	=	General Services Administration
ICP	=	inventory control point
IEEE	=	Institute of Electrical and Electronic Engineers
IGES	=	Initial Graphics Exchange Specification
ILCS	=	International Logistics Communications System
ILS	=	Inventory Locator System
IP	=	Internet Protocol
ISDN	=	Integrated Services Digital Network
JANAP	=	Joint Army, Navy, Air Force Procedures
Kbps	=	Kilobytes per second
km	=	kilometer
LAN	=	local area network
LAP-B	=	Link Access Procedure-Balanced
LED	=	light emitting diode

LINX	=	Logistics Information Exchange
LLNL	=	Lawrence Livermore National Laboratory
LMI	=	Logistics Management Institute
LOGDIS	=	Logistics Data Information System
MAC	=	Military Airlift Command
Mb	=	Megabyte
Mbps	=	Megabytes per second
MILNET	=	Military Network
MIL-STD	=	Military Standard
NAVSUP	=	Naval Supply Systems Command
NIST	=	National Institute of Standards and Technology
NLN	=	Naval Supply Logistics Network
OCONUS	=	Outside of the Continental United States
OSI	=	Open Systems Interconnection
OSINET	=	Open Systems Interconnection Network
PC	=	personal computer
PDES	=	Product Data Exchange Specification
POPS	=	Paperless Order Processing System
POSIX	=	Portable Operating System for UNIX
RFQ	=	Request for Quotation
RS-232C	=	The Electronics Industries Association (EIA) standard interface between data terminal equipment and data communications equipment employing serial binary data interchange used for low volume requirements at data rates up to 19.2 Kbps
SAMMS	=	Standard Automated Materiel Management System
SGML	=	Standard Generalized Markup Language
SMSCRC	=	Standard Multiuser Small Computer Requirements Contract
SMTP	=	Simple Mail Transfer Protocol

SNA	=	Systems Network Architecture
SPEDE	=	SAMMS Procurement by Electronic Data Exchange
SQL	=	Structured Query Language
TCP	=	Transmission Control Protocol
TELNET	=	The INTERNET standard protocol for remote terminal connection service
TISP	=	Technical Information System Program
TLRN	=	Technical Logistics Reference Network
T1	=	1.5 Mbps Standard used in the United States
USC/ISI	=	University of Southern California's Information Sciences Institute
VAN	=	value-added network
V.35	=	Consultative Committee on International Telephony and Telegraphy (CCITT) standard governing data transmission at 48 – 64 Kbps
WAN	=	wide-area network